Institutional Isomorphism and Adoption of Building Information Modelling (BIM) in Small and Medium-sized Enterprises (SMEs) of the Nigerian Construction Industry

Purpose: Although there has been a surge in the adoption of building information modelling (BIM) in the construction industry, the small and medium-sized enterprises (SMEs) are still struggling and perceive its adoption as risky. The SMEs in developing economies are especially on the disadvantaged side of the digital divide. Extant studies have focused on large firms and there are scanty studies on the influence of the external environments on BIM adoption in SMEs. Thus, this study espouses institutional theory (INT) to examine the influence of coercive, mimetic, and normative pressures on BIM awareness and adoption in SMEs.

Approach: A quantitative approach was employed, and data was collected from the Nigerian construction SMEs via an empirical questionnaire survey using a sequential stratified and convenient sampling method. Hypothesized relationships between the coercive, mimetic, and normative pressure and BIM in SMEs were empirically tested using the partial least squares structural equation modelling (PLS-SEM) technique and the model was validated with the "PLSpredict" procedure.

Findings: The results revealed that coercive and mimetic pressures significantly influence BIM adoption in SMEs while normative pressures have the strongest influence on BIM in SMEs. Also, BIM awareness is an important predictor of BIM adoption. The findings also shed light on the influence of firmographics on BIM awareness and adoption in Nigerian SMEs.

Originality: The study empirically validates the applicability of INT and highlights that BIM adoption is not only influenced by internal responses to the need for efficiency but also by external pressures. It implies a clear need for intentional isomorphic pressures in driving BIM adoption in SMEs. The study employs the INT to explain a phenomenon that has not been theoretically explored in the context of SMEs in developing economies. Lastly, the study provided valuable insights into driving BIM adoption, together with the effective practical implications for implementation and potential research areas for further studies.

Keywords: Institutional isomorphism; Coercive pressures; Mimetic pressures; Normative pressures; BIM adoption; SMEs; Developing economies; Construction industry

1.0 Introduction

Albeit Building Information Modelling (BIM) adoption has increased, the diffusion rate is not as envisaged due to the culture of the construction industry which often resists innovation compared to other industries (Ayinla & Adamu, 2018). Extant studies have highlighted that BIM adoption varies across different countries, organisation sizes, clients and professions (Hong et al., 2020). Developed economies are implementing BIM faster than most developing economies as a result of the existing digital divide and government supports (Saka et al., 2022a). Similarly, more large firms are implementing BIM than Small and medium-sized enterprises (SMEs) in the construction industry (Hong et al., 2018). These SMEs have limited access to resources and invest less in innovation compared to the large firms. Consequently, the SMEs in developing economies are at the lowest ebb of the digital divide in the construction

SMEs are the backbone of the construction industry as they represent more than 90% of the firms in the industry and are vital to the economy, especially in developing economies. The adoption of BIM in SMEs is necessary for the proliferation of BIM and the competitiveness of the SMEs as nonadopters may lose out on market share (Dainty et al., 2017). Despite the significance of BIM in SMEs, there have been an underrepresentation of SMEs in extant studies and the few studies on BIM in SMEs are from developed economies (Makabate et al., 2021; Saka & Chan, 2021). The SMEs in developing economies are often indigenous firms and struggle with innovation adoption which often makes them less competitive compared to large firms and multinational firms in the construction industry (Hosseini et al., 2018). Although BIM is perceived to be risky and disruptive for SMEs, studies have suggested that SMEs can innovate against all odds (Manley, 2008; Thorpe et al., 2009). These studies have often reported the need to focus on firms' capabilities and internal environment for the SMEs to strategically innovate (Arayici et al., 2011). However, evidence have shown that firms in the construction industry can also innovate through the influence of institutional pressures and the external environment (Ahmed & Kassem, 2018).

Previous studies have explored BIM and institutional isomorphism from the perspective of implementation on projects, large firms, and developed economies (Ahmed & Kassem, 2018; Bui, 2018, 2020; Cao et al., 2014). Although these studies are important in understanding BIM and isomorphism from the employed perspectives, little is known about the perspective of the SMEs in BIM infant countries which are majorly developing economies. There is a need to explore the perspective of these SMEs because of the contextuality of BIM and the impact of firmographics on BIM adoption. These SMEs which are smaller in size compared to the large firms and have relationships with partners, competitors, professional bodies, and government in the external environment would be influenced by the isomorphic pressures. However, there is a dearth of studies on how these SMEs would react to BIM under the influence of isomorphic

Studies have asserted that SMEs can innovate through the influence of institutional pressures from the external environment. Khalifa and Davison (2006) revealed that coercive, mimetic, and normative pressures have a significant effect on the adoption decision of ICT in SMEs. Masocha and Fatoki (2018) reported the positive significant impact of coercive pressures on sustainability practices in SMEs. Similarly, Baah et al. (2021) corroborated that coercive pressures from regulatory stakeholders have a positive and significant effect on green production sustainability in SMEs. Dainty et al. (2017) suggested that coercive pressure like government mandate could have an adverse effect on the SMEs and deepens the BIM divide between the SMEs and large firms in the UK construction industry. On the other hand, Wang et al. (2020) submitted that mimetic pressures influence SMEs to imitate other firms that have successfully adopted information and communication technology adoption (ICT) in the Chinese construction industry. However, these studies focused on the general theme of ICT and specific technologies like BIM require more financial and technical resources in SMEs. Also, developed economies and some developing economies (China and Malaysia) where these extant studies have been conducted have higher level of BIM awareness, government support and growing level of BIM implementation compared to BIM infant countries in most

Consequently, this study aims to empirically investigate the effect of coercive, mimetic, and normative pressure on BIM awareness and BIM adoption in SMEs of the Nigerian construction industry (NCI) by espousing the institutional theory (INT). It employed the NCI which is a typical BIM infant country and focused on the organisation level in tandem with the perspective of Sexton et al. (2006a) that firms should be the major focus for change in the construction industry. These serve as major points of departure from extant studies and form existing gaps in the literature that this study aims to fill in. One of the theoretical contributions of this study is its application of institutional theory to explain a phenomenon that has yet to be adequately explored and understood theoretically. The study also attempts to link the 'innovation-decision phases of diffusion theory (DT) with the institutional theory to explain BIM diffusion under the influence of the external environment which is lacking in DT. Thus, it contributes to an incremental extension of the knowledge of the theory and its applicability. Empirical contributions of the study lie in its examining of the relationships between institutional pressures and BIM adoption in SMEs of a BIM infant country; and in its exploring of the influence of firm size, firm age, and organisation type on BIM. Also, the study highlights the contextualist perspective of institutional isomorphism and presents the perspective of an underrepresented group in extant studies.

2.0 Literature Review

This section presents a review of the extant literature on BIM in the Nigerian construction industry and the theoretical background for the study. The isomorphic pressures which take roots from the institutional theory were contextualized in this study and hypotheses were proposed based on extant literature for empirical testing.

2.1 Status of Adoption of Building Information Modelling (BIM) in the Nigerian

The Nigerian Construction Industry (NCI) employs approximately a quarter of the workforce and contributes about 3 - 5% to the real gross domestic product (GDP) (National Bureau of Statistics, 2022). However, the NCI underperform compared to other sectors like manufacturing, agriculture and ICT (Olanipekun & Saka, 2019). The NCI is bedevilled with challenges such as cost & time overrun, project abandonment and lack of information reuse (Abubakar et al., 2014). With the advent of BIM, studies (Babatunde et al., 2020a; Olanrewaju et al., 2020) have posited that the industry stands to benefit from the adoption of BIM to overcome some of its challenges. However, BIM Africa (2020) reported the level of BIM implementation to be low in the NCI in tandem with other countries in Africa. Thus, previous studies have been conducted on drivers of BIM adoption and barriers to BIM adoption in the

Ogunmakinde and Umeh (2018) reported lack of awareness, lack of skilled personnel and cost of software as the impeding barriers to the proliferation of BIM. Similarly, Olanrewaju et al. (2020) identified lack of knowledge, lack of government support and high cost of implementation as the critical barriers to BIM adoption in the NCI. Babatunde et al. (2020b) corroborated and highlighted low technical know-how, inaccessibility to suitable technology and high initial capital outlay as the top-ranked barriers. These severe barriers in extant literature could be categorised into knowledge-related, cost-related, and process-related barriers. Thus, Babatunde et al. (2020a) identified competitiveness, time-saving and improved communications as the major drivers of BIM while Olanrewaju et al. (2021) reported visualization and improved decision-making process as the critical drivers. Although these studies provided the status quo of BIM in the NCI, the studies assumed BIM barriers and drivers are firm size agnostic which contradicts the findings Amuda-Yusuf (2018) in the same context. Thus, it is unclear if these drivers and barriers are applicable to firms of all sizes in the

BIM studies in SMEs are underrepresented in the literature and the majority of the extant studies are from developed economies (Saka & Chan, 2021). Kori et al. (2019) revealed that the SMEs in the Nigerian AEC are slower to adopt BIM adoption compared to large firms. Saka and Chan (2020) corroborated that this could be due to the resistance to change and the perception that BIM is risky for SMEs. Thus, Saka et al. (2020) highlighted the need to focus on the internal environment of the SMEs to drive BIM in Nigeria. The study emphasized top management support, adequate resources, flexibility, and appropriate culture as the major drivers of BIM in Nigerian construction SMEs. However, this neglects the influence of the external environment on the SMEs and begs the question of what the impacts of external pressures on the BIM diffusion process (awareness and adoption) in the SMEs are. In addition, the need to understand the impacts of external pressures on BIM adoption in Nigerian SMEs is important because the majority of the extant studies have suggested coercive pressures like BIM mandate as the most critical driver of BIM proliferation. Thus, this study aims to explore this research gap and advance the current understanding of the isomorphism and BIM adoption

2.2 Institutional Theory

Small and medium-sized enterprises (SMEs) have relationships with external organisations for business function and survival (Sexton et al., 2006b). No organisation operates independently of clients, partners, competitors, government, professional bodies, trade partners and other stakeholders in the industry. Thus, organizations are subjected to and influenced by the pressures in the external environment. In a bid to understand the influence of external pressures on BIM adoption in Nigerian construction SMEs, this study espouses the institutional theory (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). The theory argues that organisations are driven towards acceptance of policies and practices to achieve organisational goals by pressures in the institutional environment of the organisations (Teo et al., 2003). These pressures are isomorphic pressures and acts through coercive, mimetic, and normative

The arguments of this study are based on the influence of these isomorphic pressures on the BIM diffusion process in SMEs. This study contends that these pressures act on the SMEs and influence BIM awareness and subsequent BIM adoption decisions. Coercive pressures are the informal and formal pressures acting on SMEs towards isomorphism. The pressure could be in form of persuasion or force such as the government mandate to use BIM, or policies providing incentives for BIM adoption in the industry. DiMaggio and Powell (1983) assert that the greater the organisations depend on other organisations, the more likely for them to be acted upon by coercive isomorphism. This resonates with the SMEs that represent a large part of the supply chain in the construction industry and often depend on other organisations for support and collaborations. Thus, coercive pressures would have an impact on BIM awareness and influence adoption in these SMEs. On the other hand, mimetic pressures stem from the modelling of an organisation after another organisation that is seen as successful and legitimate. The large firms are adopting BIM at a faster pace compared to the SMEs, it is expected that the SMEs would model these large firms that are always pushing for BIM implementation on projects. It is perceived that the SMEs would mimic these large firms in adopting BIM towards isomorphism to work with these large firms on projects and to be perceived as an innovator in the industry.

Normative isomorphism is driven by professional bodies, education, and trade unions (Scott, 2013). The pressure stems from these sources in an attempt to conform to requirements in the environment and improve the modus of Operandi of their occupation. These could be diffused through education, conferences, seminars, and professional networks (Cao et al., 2014). In addition, the association of professionals working in the SMEs have shared norms that would affect the perception of the members. These professionals had passed through a structured education training which had imbibed certain norms and etiquettes in them and bound them to act similar, albeit they are working in different organisations. Also, third parties such as consultants and software vendors can drive the organisations towards isomorphism. DiMaggio and Powell (1983) postulate that the effects of normative pressures are more significant on organisations that rely more on academic credentials in managerial and personnel recruitment, and frequent participation of organisations in trade and professional associations. This resonates with the construction SMEs because credentials are important in recruitment to boost technical capability. Thus, through the normative pressures, SMEs would be influenced toward

Coercive pressures

Cao et al. (2014) found coercive forces to be significant in BIM adoption on construction projects in China in tandem with Ahmed and Kassem (2018) findings in architectural firms in the UK. However, this contradicts the findings of Ahuja et al. (2016) in architectural firms in India. Bui (2018) on the other hand revealed that there is a lack of coercive force on BIM implementation in the Vietnamese context because of the low level of awareness and lack of BIM champions in the industry. However, with an increase in the level of awareness, there are coercive pressures from technical organisations to showcase innovation benefits on projects in Vietnam. Dainty et al. (2017) cautioned that existing coercive pressures such as government mandate in the UK could cause a further digital divide between SMEs and large firms. This makes the effect of coercive pressures on SMEs, especially in developing economies to be unclear. Thus, the following hypotheses are proposed:

H1a: The levels of coercive pressures are positively associated with the level of BIM awareness

H1b: The levels of coercive pressures are positively associated with the level of BIM adoption in SMEs.

Mimetic pressures

Cao et al. (2014) reported the significance of the mimetic pressures on BIM adoption in construction projects in China which contradicts the findings of Ahmed and Kassem (2018) in the UK. DiMaggio and Powell (1983) postulated that the more uncertain the relationship between the goal and the means, the more it is likely for the organisation to mimic other successful firms. This aligns with the SMEs that often perceived the BIM to be complex and risky (Saka & Chan, 2021). Bui (2018) revealed that mimetic pressures are influential in a pilot infrastructural project in Vietnam through mimicking partner firms that have expertise in BIM, the presence of a BIM champion, and sharing of good practices on projects. Thus, the following hypotheses are proposed:

H2a: The levels of mimetic pressures are positively associated with the level of BIM awareness in SMEs.

H2b: The levels of mimetic pressures are positively associated with the level of BIM adoption in SMEs.

Normative pressures

Cao et al. (2014) found the influence of normative pressures to be insignificant in tandem with Ahmed and Kassem (2018). However, Tsai et al. (2013) found the pressure to be significant in a similar study. Bui (2018) revealed the presence of normative pressures which stem from participation in workshops, online channels, the competitiveness of the market and government initiative in the implementation of BIM in an infrastructural project in the Vietnamese context. Thus, the following hypotheses are proposed:

H3a: The levels of normative pressures are positively associated with the level of BIM

H3b: The levels of normative pressures are positively associated with the level of BIM adoption

Awareness

Innovation diffuses progressively in different phases and the first phase is the awareness before the forming of intention and adoption of such innovation (Rogers, 2003). Firms adopting BIM would be aware of BIM before deciding to adopt BIM in their firm. There has been an increase in the level of awareness of BIM in SMEs, however, this has not translated to an increased level of implementation. Consequently, BIM awareness is expected to be related to BIM adoption logically.

H4: The levels of BIM awareness are positively associated with the level of BIM adoption in SMEs of developing economies.

Lastly, the size of the SME (H5), organisation type(H6) and years of establishment of the SME (H7) are used as the control variables as depicted in Figure 1.

3.0 Research Methodology

Scale development, pretesting sampling and data collection

This study adopted a quantitative research approach using an empirical questionnaire survey. This is because the study aims to examine the influence of isomorphic pressures on the BIM diffusion process in SMEs, the need for generalization, and prior theoretical commitment

(Wing et al., 1998). It employed three sequential phases in achieving the objectives of the study

The first phase involves a detailed literature review of institutional theory studies on technology adoption in the construction industry. Eight indicators were adapted to measure coercive pressures (Ahmed & Kassem, 2018; Chen et al., 2019); four indicators measure mimetic pressures (Ahmed & Kassem, 2018; Cao et al., 2014; Chen et al., 2019), seven indicators measure normative pressures (Ahmed & Kassem, 2018; Cao et al., 2014; Tsai et al., 2013); two and four indicators measure BIM awareness and adoption respectively (Ahmed & Kassem, 2018; Hong et al., 2018). The reviewed indicators from extant studies were modified to suit the current study and reviewed by 2 construction professionals and 2 construction management researchers. These experts have more than 15 and 10 years of experience in the industry and academia, respectively. The wordings of coercive pressure indicators were modified based on their opinions and suggestions. The reviewed indicators were used to develop an empirical questionnaire which consists of three sections.

The first section solicits information about the SMEs, the second section solicits information about the BIM diffusion (Awareness and Adoption) in the SMEs and the last section solicits information about the isomorphic pressures as regards BIM. The second and third section of the questionnaire contains multi-items measured with a 5-point Likert scale which ranges from strongly disagree (1) to strongly agree (5). Likert scale of measurement was employed because of its adequacy in capturing respondent views, allows a lower error margin, does not provide overwhelming options and it has been used in several similar previous studies (Ekanayake & Ofori, 2004; Jepson et al., 2020; Saka et al., 2022b).

The second phase involves a pilot survey with 30 respondents to evaluate the validity of the tool. Comments and feedback were provided on improving the questionnaire introduction to explicitly specify the targeted respondents as SMEs, ensure the respondents have BIM knowledge, remove questions relating to the firm's annual turnover and replacement with the number (size) of employees. The results and comments from the pilot survey were adopted to improve the presentation and clarity of the survey questionnaire, however, none of the indicators was removed (all the indicators loaded under the right constructs). The second phase also involves the administration of the main survey in the SMEs of the Nigerian Construction Industry (NCI). The last phase of the study involves data analysis of the collected data.

According to the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN, 2017), SMEs are enterprises with less than 200 employees and there are 905,145 enterprises in the Nigerian construction sector. Per Krejcie and Morgan (1970) guidelines for determining sample size, with an assumed standard error of 0.05 the sample size is 384. Hair et al. (2010) recommends doubling the sample size (768) to reduce error and solve nonresponsive error (Eniola et al., 2019). A sequential sampling method of stratified and convenient sampling was employed. Stratified sampling was adopted to categorise the different regions in Nigeria into different strata and a convenient sampling technique was employed for survey administration in each region. The questionnaires were distributed physically to construction firms' offices

The data was collected within the span of 5 months in Nigeria. Out of the 768 distributed questionnaires, a total of 550 forms were returned. However, only 489 questionnaires were filled and valid, met the criteria of the survey and represented a response rate of 63.67%. This is considered adequate as the collected questionnaire forms are above 384 (sample size). Table 1 shows the demographic distribution of the respondent construction SMEs.

Insert Table 1: Demographic Distribution of Survey Respondents

Partial least squares structural equation modelling (PLS-SEM) technique was adopted in this study over covariance-based structural equation modelling (CB-SEM) because: (1) the study involves explaining the effects of isomorphic pressures on BIM in the SMEs; (2) non-normal data distribution; (3) the method's statistical power; and (4) PLS-SEM is suitable for confirmatory and predictive research and overcome the existing dichotomy (Hair et al., 2017; Hair et al., 2019). In addition, the perspective of the study is to test a theory (explanation) and offers recommendations for management practices via prediction (Gregor, 2006). The analysis was conducted using *SmartPLS 3* per the guide provided by Hair et al. (2016).

4.0 Data Analysis

The data analysis of the PLS-SEM consists of the measurement model and the structural model. The measurement model depicts the relationship between the indicators (observed variables) and the latent variables while the structural model depicts the relationship between the latent variables based on the theoretical framework adopted in this study. The proposed relationships are then validated with out-of-sample using the "PLSpredict" procedure (Hair et al., 2021).

4.1 Measurement Model

Per Hair et al. (2016) the measurement model is evaluated for internal consistency, convergent validity and discriminant validity as shown in Table 2.

Insert Table 2: Evaluation of measurement model

The internal consistency reliability which measures how the observed variables for each of the latent variables measuring the same item were evaluated using Cronbach's alpha reliability test. However, due to the limitation of Cronbach's alpha, it is combined with composite reliability and Dillon-Goldstein's rho (Sanchez, 2013). Cronbach's alpha and Dillon-Goldstein's rho value range from 0 to 1 and a value of 0.70 is considered a minimum threshold while a value above 0.95 is considered undesirable (Hair et al., 2016). Similarly, the composite reliability value ranges from 0 to 1 and 0.70 is considered the threshold (Gefen et al., 2000). All the latent variables in the study have values above 0.70 and are considered to have internal consistency as shown in Table 2. The convergent validity which measures the extent to which observable variables of the same latent variable correlate is evaluated using the outer loadings, and average variance extracted (AVE) per Hair et al. (2016). The outer loading of all the indicators is above the 0.50 minimum threshold (Nunnally, 1978) and the AVE values which reflect the communality of the construct are all above the minimum threshold of 0.50 (Fornell & Larcker, 1981). The values of the outer loadings and the AVE indicate the convergent

The constructs are evaluated for discriminant validity which is a measure of the extent to which a construct empirically differs from other constructs (Hair et al., 2016). This is evaluated using the cross-loadings, Fornell-Larcker criterion and the Heterotrait-monotrait ratio (HTMT) as shown in Table 3 and Table 4. Fornell-Larcker criterion compares the AVE (square root) with the constructs' correlation, and the square root of the AVE should be greater than its correlation with other constructs (Fornell & Larcker, 1981). Table 3 shows that all the diagonal values are greater than all the off-diagonal values for each construct which shows that discriminant validity is established.

Insert Table 3

Lastly, the Heterotrait-monotrait ratio (HTMT) is used to evaluate the discriminant validity as shown in Table 4. HTMT is an estimate of the correlation between construct and comparison to a threshold of 0.85 or 0.90 to determine discriminant validity (Henseler et al., 2014). All HTMT values are all below the conservative threshold of 0.85 which reinforces that discriminant validity is established (Hair et al., 2021)

Insert Table 4

The structural model is assessed for collinearity using the variance inflation factors (VIF) which are all below the threshold of 5 signifying that there is no collinearity problem in the construct (Hair et al., 2016). The structural model is subsequently assessed for its significance of the path coefficient, coefficient of determination (R^2), effect size (f^2) and predictive relevance (q^2).

The significance of the path coefficient and statistical error was computed using complete bootstrapping with 5,000 subsamples and the coefficient of determination which is the measure of the model's predictive power was calculated. The effect size (f^2) which is the value of R^2 when a selected construct is omitted and included from the model was computed by estimating the PLS path model twice for each construct. Per Cohen (2013), the effect size value of 0.02, 0.15 and 0.35 represent small, medium and large effects respectively. Similarly, the predictive relevance q^2 which is a measure of the model's 'out-of-sample predictive power' (Hair et al., 2019) is obtained through blindfolding with an omission distance of 7. The predictive relevance is small for value $0.02 \leq f^2 < 0.15$, medium for value $0.15 \leq f^2 < 0.35$, and large for value $f^2 \geq 0.35$ (Henseler et al., 2009). Table 5 shows the path significance, computed effect size and predictive relevance. The coefficient of determination of BIM awareness and adoption is 0.307 and 0.562 respectively which signifies that substantial variance in the constructs is explained by the model. Also, it implies that 31% of BIM awareness and 56% of BIM adoption in SMEs are due to the isomorphic pressures which represent a satisfactory predictive accuracy of the structural model.

A two-tailed t-test was used in evaluating the path and each path represents a hypothesis. Decisions were made based on conventional significance levels of 0.01 and 0.05 as shown in Table 5. Out of the thirteen hypothesised relationships, eight hypotheses were significant. The path coefficient between coercive pressures and BIM awareness and adoption (H1), and the path coefficient between mimetic pressures and BIM adoption (H2b) are significant. Similarly, the path coefficient between normative pressures and BIM awareness and adoption (H3). All the hypotheses were excepted because their t-values are greater than 1.96 save for hypotheses

Per Cohen (2013), coercive pressures, and normative pressures affect BIM awareness, however, the effect size of coercive pressures on BIM awareness in SMEs is considered large. On the other hand, normative pressures, and awareness affect BIM adoption, however, normative pressures have more effect on BIM adoption. Similarly, per Henseler et al. (2009) coercive pressures and normative pressures have substantial predictive relevance for BIM awareness and BIM adoption in SMEs respectively. Lastly, these effect sizes and predictive relevance are above the minimum threshold value.

Insert Table 5: Hypothesis testing results

4.3 Validation of the Developed Model

The R^2 values for BIM awareness and adoption show that about 31% and 56% of the variance can be explained by the proposed model. Similarly, the model's predictive quality was evaluated through blindfolding and computation of predictive relevance. However, these are done in an explanatory modelling context and do not provide information about out-of-sample prediction. Thus, per Shmueli et al. (2019), the PLSpredict procedure is employed to validate the model using cross-validation. This approach is based on the k-fold cross-validation and 10 folds (k) with 10 repetitions were employed in its computation. The prediction error generated for the main constructs (awareness and adoption) was plotted and revealed symmetric distributions. Thus, root mean squared error (RMSE) is used for the prediction statistics instead of mean absolute percentage error (MAE) (Shmueli et al., 2019). The prediction statistics are shown in Table 6.

Insert Table 6

The root mean squared error (RMSE) and the naïve benchmark (Q^2_predict) are computed for the PLS-SEM and linear regression (Model) in the SmartPLS tool per PLSpredict procedure. Q^2_predict values > 0 indicate that the PLS have predictive power and can be compared with the naïve LM benchmark. The comparison outcome revealed that all the indicators in the PLS-SEM have lower RMSE compared to the naïve LM benchmark save for one indicator (AD3). Thus, the proposed model has high predictive power per PLSpredict procedure and good explanatory power as earlier established with the R^2.

All the indicators have loadings above 0.50 with 0.645 (CPR6) and 0.836 (CPR2) as the minimum and maximum, respectively. The indicators with the top loadings which are CPR2, CPR5 and CPR1 reflect the perceived coercive pressures by the SMEs. This shows that the perceived coercive pressures are emanating from the trading partners, competitors and clients with lesser influence from the government through the BIM mandate and policies which is in tandem with Saka and Chan (2020). It reinforces Makabate et al. (2021) that there is a lack of government support for BIM in SMEs of developing countries. Also, the lack of perceived forces from the government by the SMEs could be a result of their less participation in projects with BIM mandate as explained by Lam et al. (2017) in the UK context. However, this is not the case in a developing economy like Nigeria where there is a lack of clear government direction and mandate. Thus, the perception of SMEs reflects the status quo.

The findings support hypothesis H1a (β = 0.121) that the levels of coercive pressures are positively associated with the level of BIM awareness in SMEs. However, this contradicts the findings of Ahmed and Kassem (2018) in architectural firms in the UK construction industry.

A possible explanation could be the ability to either force or persuade SMEs possessed by the organisations they depend on in developing economies. On the other hand, per hypothesis H1b ($\beta = 0.083$) there is a significant relationship between coercive pressures and BIM adoption in SMEs in agreement with Ahmed and Kassem (2018). This also supports the findings of Bui (2018) that in the absence of government mandate as a coercive pressure to adopt BIM, pressures from clients, competitors and trade partners could influence BIM adoption in developing countries. Although Cao et al. (2014) findings do not support the significance of the direct relationship between coercive pressure and BIM adoption on projects from the Chinese context. The study supports the influence of coercive pressure on BIM adoption through the mediation of client support which broadly agrees with this present study. The implication is that coercive pressures can be used in advocating for BIM adoption using pressures such as client requirements and competitors' and trade partners' pressures. Similarly, Wang et al. (2020) reported the non-significance of coercive pressure on ICT adoption in SMEs from the Chinese context. Government mandate and client requirements would leave the SMEs working on public projects or clients' projects with no choice but to adopt BIM. However, caution should be taken in using force such as government mandate to push BIM adoption in SMEs, to avoid further digital divide between the SMEs and large firms as highlighted by Dainty et al. (2017) in the UK construction industry. Interestingly, although coercive pressures have effect on BIM awareness and BIM adoption, the path coefficient to BIM awareness is stronger than BIM adoption in this study. This implies that coercive pressures have more effect on BIM awareness than BIM adoption, which broadly agrees with Ayinla et al. (2021) that BIM mandate often improves BIM awareness than adoption. This is also corroborated by the effect size and predictive relevance of coercive pressures on BIM awareness which are large and medium respectively.

Mimetic pressures

All the indicators have loadings above 0.50 with 0.679 and 0.784 as the lowest and highest, respectively. The top perceived mimetic pressures are emanating from project consultants and trading partners which reflects the findings of Bui (2018) that firms are likely to adopt BIM through mimicking consultants and trade partners that are proficient in BIM implementation. The least perceived mimetic pressure relates to the perception that the large firms in the construction industry are adopting BIM and could signify the low level of adoption in the large firms in developing countries compared to developed countries.

The findings of this study do not support the relationship between mimetic pressures and BIM awareness in tandem with Ahmed and Kassem (2018), however, in contrast, this present study does find a significant influence of mimetic pressures on BIM adoption per H2b ($\beta = 0.136$). This is also supported by Wang et al. (2020), Cao et al. (2014) and Kale and Arditi (2010) that mimetic pressures could serve as a source of innovation diffusion in the construction industry. Thus, it can be said that mimetic isomorphism is significant in BIM adoption in SMEs of developing economies at the organisation level. This could be partly explained by project consultants' influence on the SMEs and the influence of trading partners that have adopted BIM. In a bid to synchronise with these parties the SMEs turn to mimicry which could be intentional or unintentional (Bui, 2018). Lack of BIM compliant SMEs in the presence of increasing BIM compliant large firms might discourage the SMEs to perceive BIM to be meant for large firms alone in tandem with Hosseini et al. (2016). Thus, mimicking such large firms with slack resources to try out innovation might be seen as illogical by the SMEs and broadly agrees with the liability of smallness (Hannan & Freeman, 1984).

Normative pressures

All the indicators have loadings above 0.50 with 0.634 and 0.760 as the lowest and highest loading, respectively. The perceived normative pressures with the highest loadings are related to professional bodies, industry, and software vendors. Professional bodies advocate for BIM adoption thereby influencing the professional practice of their members and the diverse organizations these members worked. Similarly, software vendors advocate BIM adoption by providing incentives and support for organizations toward BIM implementation. Albeit one of the main aims of these vendors is to make profits and rarely advocate for a software agnostic approach in their drive. Thus, some authoring tools are common in Nigerian SMEs through push strategies by the software vendors (BIM Africa, 2020). Perceived normative pressures with the least loadings relate to the availability of BIM professionals and avenues for BIM implementation. This broadly corroborates Olanrewaju et al. (2020) and Ahmed and Suliman (2019) from a similar context.

The findings of this study support H3a ($\beta = 0.457$) that normative pressures are positively related to BIM awareness in contradiction to Ahmed and Kassem (2018) findings. It also supports H3b ($\beta = 0.158$) that normative pressures have a positive significant influence on BIM adoption which contradicts Cao et al. (2014), Ahuja et al. (2016), Wang et al. (2020) and Ahmed and Kassem (2018). This differs from extant studies on normative isomorphism and BIM in the literature and could be explained by the difference in context (size and location of the study). It agrees with Toole (1998) that the adoption of technological innovations in SMEs is often influenced by information from professional bodies. This might imply that normative pressures are more significant in smaller size firms compared to large firms. The finding could also be related to the reliance on professional certifications in recruiting managers and top management teams in the industry in tandem with DiMaggio and Powell (1983) hypothesis. Construction SMEs recruit professionals with recognized certifications and membership as it does help during technical evaluation in bid evaluation for contract awards. SMEs are evaluated for technical capacity through their staff experience and professional membership; thus, the professionalization effect is significant in construction SMEs. Professional bodies would have an influence on the professionals who would in turn influence decision on BIM adoption in their organisations. Also, it is common in the Nigerian construction industry to have organised conferences, seminars, and workshops on BIM in a bid towards increasing awareness and adoption. However, as noted by Bui (2018) some of the BIM conferences often lack rigorous practical learning.

BIM Awareness and Adoption

BIM awareness has a significant influence on BIM adoption in SMEs. This is logical as the awareness is a stage toward BIM adoption per Rogers (2003). However, not all SMEs that are aware of BIM are adopting BIM per Saka et al. (2019). This means awareness does not automatically equate to BIM adoption. The size of the SMEs, however, does not have a significant influence on BIM awareness and adoption as both small and medium-sized firms do not show a significantly different level of awareness and adoption. This is consistent with the findings of Hosseini et al. (2018) and Papadonikolaki and Aibinu (2017). The findings however support the influence of years of establishment and organisation type of BIM awareness but not on BIM adoption. This signifies that firms that have been existing longer in the construction industry and consultancy firms have a higher level of awareness compared to young firms and contracting firms which agrees partly with Chen et al. (2019). Similarly, consultancy firms have prior exposure to the use of CAD before BIM and corroborate the findings of Saka et al. (2022a). Also, the coefficient of determination for BIM awareness and adoption in the study is 0.307 and 0.562 respectively with few exogenous constructs which indicates a parsimonious model with a satisfactory predictive level (Hair et al., 2016).

On the other hand, BIM adoption is influenced by awareness, coercive, mimetic, and normative pressures, however, the influence of awareness is the strongest while normative pressures have the strongest influence among the isomorphic pressures. This contradicts the findings of Cao et al. (2014) and Ahmed and Suliman (2019) and could serve as differences between isomorphic pressures in different economies and firm sizes. Lastly, the proposed model was validated which revealed that the model has high predictive power coupled with explanatory power. The average RMSE for BIM awareness and adoption are 1.00 and 0.962 respectively which implies that 68% of the prediction error would fall within approximately 2 points of the five-point Likert scale.

6.0 Conclusions

SMEs cannot exist without the institutions such as the government, trade partners, professional institutions and client organisations. This is because the construction industry is a multi-stakeholder industry where one firm often depends on another firm. However, the construction industry is usually fragmented and slow with innovation adoption, and thus the SMEs often bear the brunt of the digital divide. Evidently, the traditional model of SMEs characterized by a lack of digitization and innovation is no longer viable in recent years, especially in developing economies where these SMEs are often indigenous firms. These SMEs need to either adapt or lose out of market share to competitors and large firms. Consequently, the need to study the influence of institutional isomorphism and BIM adoption in SMEs is of paramount importance.

The study examined the influence of isomorphic pressures on BIM diffusion (from awareness to adoption) in Nigerian SMEs. The study findings revealed that isomorphic pressures have a significant influence on BIM adoption decisions in these SMEs. However, it does not provide ample support for mimetic isomorphism toward improved BIM awareness in SMEs. These research findings have significant implications for both theory and practice. The study revealed that coercive pressures have significant effects on BIM awareness and adoption but underscore a stronger effect on BIM awareness. This sheds light on the effect of pressures like the BIM mandate on SMEs from a developing economy perspective. It revealed that although the BIM mandate could lead to more awareness than real adoption, it does not have a negative effect on

BIM adoption in SMEs nor push them away. It implies that policymakers and stakeholders can leverage coercive pressures to drive BIM in SMEs without causing a further digital divide. Coercive pressures from regulatory bodies would lead to increased awareness of BIM in the SMEs of developing countries and subsequent adoption. Thus, the current bottom-up strategies for driving BIM in Nigeria would benefit from a top-down approach through coercive isomorphism.

Similarly, the significance of the proposed relationships between normative pressures and BIM diffusion in Nigerian SMEs deviates from extant literature which has often suggested that normative pressures do not affect BIM adoption in the construction industry. This implies that Nigerian SMEs are experiencing pressure from trained personnel, industry consultants, industry associations, software vendors and other stakeholders to adopt BIM. The influence of these normative pressures is more significant than other isomorphic pressures and suggests that normative isomorphism is more relevant in this context. It generates the need for the professional bodies to improve on upskilling and regular training of their members by providing more hands-on demonstration and usage sessions for them beyond mere attendance to conferences and workshops. Also, there is a genuine need to improve the certification process and education training of various construction professionals towards producing BIM-compliant graduates and professionals in town. Interestingly, the study findings support mimetic isomorphism despite the low level of adoption of BIM in SMEs compared to the large firms in Nigeria. This implies that BIM adoption could be positively influenced by the availability of more SMEs that have successfully adopted BIM which other SMEs would consider as role models in developing economies. Thus, the government and stakeholders should support SMEs that have high readiness to implement BIM successfully as these would in turn serve as a clear guide for other SMEs. In addition, the findings imply the need for contextuality of BIM studies and the need to be context-conscious in advocating for global

BIM solutions. It suggests that in the absence of coercive pressures, normative and mimetic pressures are also effective in driving BIM adoption in SMEs of developing economies. Finally, it empirically validates and extends the applicability of the institutional theory in BIM adoption by SMEs.

The study has an inherent limitation based on its adoption of the Nigerian Construction Industry (NCI) as a case study for developing economies. However, the case study was selected because of its high level of BIM awareness and low level of adoption which is synonymous with most developing countries. Also, the data was collected during the second wave of the COVID-19 global pandemic where SMEs are forced to innovate a new approach to collaborating and working with each other. Further research studies could consider examining the influence of these isomorphic pressures and internal pressures on BIM diffusion simultaneously in the SMEs of developed and developing economies.

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Table 1: Demographic Distribution of Survey Respondents

Profession	**Frequency**	**Percentage**
Architecture	120	24.54
Civil / Structural Engineering	101	20.65
Quantity Surveying	94	19.22
Mechanical Engineering and Building Services	40	8.18
Builder	106	21.68
Estate Surveying / Facility Management	28	5.73
Organization type	**Frequency**	**Percentage**
Contracting	280	57.26
Consultancy	209	42.73
Years of establishment	**Frequency**	**Percentage**
< 5 years	29	5.93
6–10 years	68	13.91
11–15 years	138	28.22
16–20 years	125	25.56
> 20 years	129	26.38
Region	**Frequency**	**Percentage**
Southwest	281	57.5
South South	26	5.3
Southeast	23	4.7
North Central	108	22.1
Northeast	11	2.2
Northwest	40	8.2
Position of Respondent	**Frequency**	**Percentage**
Managing Director	184	37.6
Senior Level Staff	267	54.6
Middle Level Staff	15	3.1
Technical Staff	23	4.7

Table 2: Evaluation of measurement model

Construct	Item	Loading	Cronbach's alpha value	Rho	AVE	CR
BIM awareness			**0.865**	**0.867**	**0.787**	**0.917**
Our organization is aware of BIM tools.	AW1	0.879				
Our organization is aware of the benefits of BIM implementation.	AW2	0.916				
Our organization has enough information about BIM adoption.	AW3	0.866				
BIM adoption			**0.782**	**0.798**	**0.699**	**0.874**
The organization encourage its staff to use BIM in regular workflow, even without BIM being the official workflow process at the organization.	AD1	0.879				
The organization intends to implement BIM on projects, regardless of its implementation level.	AD2	0.882				
There is interest in learning BIM tools and workflow in our organization	AD3	0.74				
Coercive pressures			***0.885***	***0.9***	***0.553***	***0.908***
Our clients are demanding the use of BIM on their projects.	CPR1	0.799				
There is pressure from trading partners to implement BIM.	CPR2	0.836				
There is BIM mandate from the government for compulsory use of BIM.	CPR3	0.716				

The government provides adequate support for BIM adoption through incentives and policies.	CPR4	0.709				
Our firm is under pressure from competitors to adopt BIM.	CPR5	0.813				
Some of our competitors have already started using BIM.	CPR6	0.645				
Firms that have adopted BIM do not want to work with other non-adopting firms.	CPR7	0.664				
Industry associations require our firm to use BIM.	CPR8	0.743				
Mimetic pressures			***0.717***	***0.726***	***0.539***	***0.823***
Leading organizations are adopting BIM in the industry.	MPR1	0.679				
We know that our trading partners are ready to use BIM.	MPR2	0.765				
Project consultants are generally very knowledgeable regarding BIM technical matters.	MPR3	0.784				
Firms that have adopted BIM benefited greatly.	MPR4	0.704				
Normative pressures			***0.84***	***0.847***	***0.511***	***0.879***
There are BIM professionals within the market.	NPR1	0.668				
Industry consultants strongly advocate the adoption of BIM in our type of organization	NPR2	0.714				
Industry associations strongly propagate the value of BIM in our type of organization	NPR3	0.76				

Software vendors strongly advocate the adoption of BIM in our types of organization.	NPR4	0.735			
There are several avenues (conferences, seminars, workshops, forums, meetings) that discuss BIM implementation.	NPR5	0.634			
There is high level of BIM awareness within the industry.	NPR6	0.752			
There is high level of information sharing with other contractual partners as regards BIM.	NPR7	0.73			
Firm size	Employee	1	1	1	1
Organisation Type	Org.typ	1	1	1	1
Firm age	Years	1	1	1	1

Table 3: Discriminant validity results of the variables in various constructs

Construct	Firm age	BIM awareness	BIM adoption	Coercive pressures	Mimetic pressures	Normative pressures	Org. type	Firm size
Firm age	**1.000**							
BIM awareness	0.042	**0.887**						
BIM adoption	0.029	0.700	**0.836**					
Coercive pressures	-0.130	0.315	0.371	**0.744**				
Mimetic pressures	0.000	0.395	0.485	0.451	**0.734**			
Normative pressures	-0.049	0.528	0.560	0.405	0.661	**0.715**		
Org. type	-0.084	0.129	0.111	0.097	0.071	0.079	**1.000**	
Firm size	0.435	0.017	-0.005	-0.017	0.068	0.045	-0.174	**1.000**

Table 4: Heterotrait-monotrait ratio (HTMT) results of the variables in various constructs

Construct	Firm age	BIM awareness	BIM adoption	Coercive pressures	Mimetic pressures	Normative pressures	Org. type	Firm size
Firm age	-							
BIM awareness	0.044							
BIM adoption	0.101	0.846						
Coercive pressures	0.146	0.336	0.422					
Mimetic pressures	0.133	0.494	0.642	0.534				
Normative pressures	0.086	0.61	0.684	0.448	0.848			
Organisation type	0.084	0.139	0.128	0.092	0.096	0.093		
Firm size	0.435	0.036	0.082	0.042	0.115	0.075	0.174	-

Table 5: Hypothesis testing results for various constructs

Hypothesis	Relationships	Std Beta	Std Error	t-value	Decision	f^2	q^2	95% LL	95% UL
H1a	Coercive pressures → Awareness	0.121	0.039	3.053^{***}	Supported	*0.454*	*0.224*	0.056	0.185
H1b	Coercive pressures → BIM Adoption	0.083	0.039	2.111^{**}	Supported	0.016	0.010	0.019	0.147
H2a	Mimetic pressures → Awareness	0.037	0.049	0.731	Not supported	0.011	0.005	-0.044	0.117
H2b	Mimetic pressures → BIM Adoption	0.136	0.048	2.802^{**}	Supported	0.001	0.000	0.058	0.214
H3a	Normative pressures → Awareness	0.457	0.046	9.914^{***}	Supported	*0.021*	0.011	0.382	0.531
H3b	Normative pressures → BIM Adoption	0.158	0.055	2.875^{**}	Supported	*0.165*	*0.115*	0.068	0.250
H4	Awareness → BIM Adoption	0.534	0.040	13.553^{**}	Supported	*0.027*	0.013	0.469	0.599
H5a	Size → Awareness	-0.033	0.042	0.787	Not supported	0.001	0.001	-0.102	0.037
H5b	Size → BIM Adoption	-0.048	0.036	1.345	Not supported	0.005	0.002	-0.107	0.011
H6a	Org. type → Awareness	0.082	0.036	2.221^{**}	Supported	0.009	0.005	0.023	0.142
H6b	Org. type → BIM Adoption	0.009	0.030	0.265	Not supported	0.000	-0.002	-0.040	0.058
H7a	Years of Estab. → Awareness	0.100	0.043	2.322^{**}	Supported	0.012	0.008	0.026	0.171
H7b	Years of Estab. → BIM Adoption	0.046	0.036	1.309	Not supported	0.005	0.000	-0.012	0.105

**p < 0.01, *p < 0.05. Effect size indicators are classified according to Cohen (2013), f^2 values: 0.35 (large), 0.15 (medium) and 0.02 (small). Predictive relevance (q^2) of predictor exogenous latent variables are classified according to Henseler et al. (2009), q^2 values: 0.35 (large), 0.15 (medium) and 0.02 (small).

Table 6: “PLSpredict” validation results

Constructs	**Indicators**	**PLS**		**LM**		**PLS-LM**	
		RMSE	**Q^2_predict**	**RMSE**	**Q^2_predict**	**RMSE**	**Q^2_predict**
BIM Awareness	AW1	0.986	0.197	0.993	0.187	-0.007	0.010
	AW2	1.001	0.232	1.006	0.225	-0.005	0.007
	AW3	1.013	0.248	1.022	0.234	-0.009	0.014
BIM Adoption	AD1	1.004	0.252	1.028	0.217	-0.024	0.035
	AD2	0.933	0.270	0.950	0.244	-0.017	0.026
	AD3	0.951	0.195	0.947	0.202	0.004	-0.007

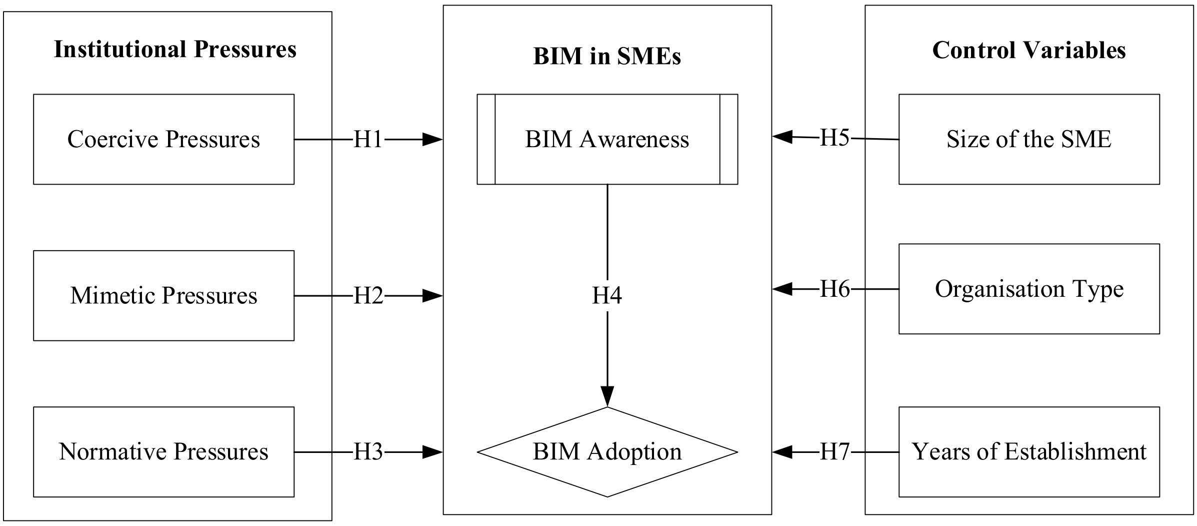

Figure 1: Research Framework of the Study

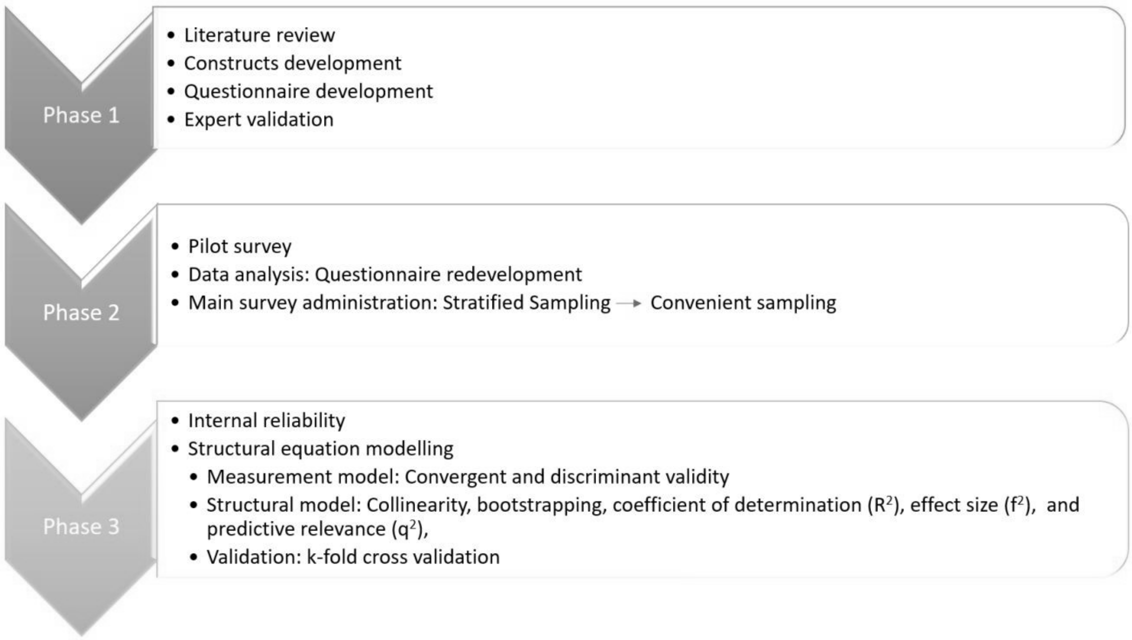

Figure 2: Research Methods Adopted by the Study